# Lisfranc Ligament Injuries

## OVERVIEW

Lisfranc injuries are not common. They represent 0.2% of all fractures with an incidence of 1 in every 55,000 patients in the US. Lisfranc injuries have traditionally been associated with high-energy trauma such as motor vehicle collisions and industrial accidents

Almost 40% of Lisfranc fracture dislocations in polytrauma patients are not recognized, and 20% are misdiagnosed. Recently, there has been a greater appreciation of midfoot sprains that represent a brand new spectrum of injury to the Lisfranc ligament complex. These are low-energy, sport-related injuries.

## ANATOMY

The 3 cuneiform bones, as well as the bases of the first, second, and third metatarsals, are wedge-shaped and, together with the fourth and fifth metatarsals and the cuboid form, a balanced arch in the frontal plate of the midfoot. The keystone of this stable arrangement is the base of the second metatarsal. It has an intrinsic static stability, due to its recessed position, and complex ligament structures to support this stability during gait.

There are 3 layers of ligament connecting the cuneiforms and the cuboid to the metatarsal bases: the dorsal, interosseous, and plantar ligaments. Biomechanically the strongest layer is the interosseous ligament, followed by the plantar, with the dorsal complex being the weakest. This may account for the dorsal direction of dislocations.

The stability between the medial and middle cuneiforms is provided by the Lisfranc ligament, which spans between the medial cuneiform and the base of the second metatarsal. This is the largest of the interosseus ligaments and measures 1 cm in height by 0.5 cm in width.

## BIOMECHANICS: Columns Theory

The entire midfoot is divided into three columns. The lateral column is the most mobile and consists of the articulation between the fourth and fifth metatarsals and the cuboid. The navicular bone, the medial cuneiform, and the first metatarsal give shape to the medial column. The middle column is the most rigid, consisting of the second and third metatarsals and their respective TMT articulations.

## PATHOGENESIS

High-energy trauma can produce major anatomy alteration in a convergent or divergent pattern of dislocation. On the other hand, low energy trauma can act with either a direct and indirect mechanism.

The direct mechanism of injury invovles crushing trauma directly to the midfoot, usually from a falling object. The indirect mechanism is described as an axial load applied to a plantar-flexed and slightly rotated foot, followed by an abrupt abduction or twisting. The most common scenario is when a football player falls on the heel of another player's plantar-flexed foot while the metatarsophalangeal joints are maximally dorsiflexed. Although it is common to fracture the cuneiform, the second metatarsal base is the most commonly fractured component of the TMC.

## CLINICAL PRESENTATION

Diagnosis of a high-velocity injury such as an automobile accident, crushing injury, or a fall from a height is fairly straightforward. This injury presents with significant edema to the foot accompanied by severe pain and midfoot instability. The injuried foot may seem wider or flatter on bilateral comparison to the uninjured foot. Midfoot swelling and plantar ecchymosis are pathognomonic for a Lisfranc injury.

Diagnosis of a low-velocity injury is more difficult. Athletes may underestimate the severity of the injury, especially if they are still weight bearing. The ankle is usually stable and pain free with no swelling or ecchymosis. It is important to perform a thorough clinical examination to avoid mistaking a foot sprain for an ankle sprain, a common (65%) and dangerous mistake.

## EXAMINATION

According to Jeffreys, the pure tarsometatarsal ligament lesion injury pattern depends on the application of rotational forces to a plantar-flexed foot while the forefoot is firmly planted on the ground. It is important to clarify the direction of the forces applied to the foot during the trauma, as it can give an indication of which structures are injured. With inversion forces, the dorsal and interosseous ligaments are typically injuried; with eversion forces, the plantar and interosseous ligaments may be affected. The application of rotational maneuvers to the forefoot while the hindfoot is kept stable is a useful tool to clarify traumatic movements.

The patient may or may not be weight bearing with a complaint of slight to severe pain. The following bony landmarks should be palpated for tenderness: navicular, medial, and middle cuneiforms; bases of metatarsals 1 to 5; and the first intermetatarsal space. Passive pronation and supination of the forefoot can assess the stability of the Lisfranc complex, and if this maneuver produces pain, can indicate a Lisfranc injury. If the patient is manifesting more subtle symptoms of a Lisfranc injury, provocation may be achieved by holding the hindfoot fixed in one hand and passively abducting and pronating the forefoot with the other hand.

Depending on the amount of edema present, palpation of the dorsalis pedis pulse may prove difficult. In cases of severe edema and pain, compartment syndrome should be suspected.

## CLASSIFICATION

The most recent classification of high-energy trauma has been proposed by Myerson et al. according to congruity (pattern of metatarsal separation from the tarsals), direction (medial or lateral), and amount of displacement (partial or total).

A more recent classification system has been described for low-energy trauma by Nunley and Vertully. According to these investigators:

Stage I consists of a tarsometatarsal ligament sprain without diastasis between the bones or loss of the medial arch height on weight-bearing radiographs. The Lisfranc complex is stable.

Stage II shows diastasis of up to 5 mm between the medial cuneiform and the base of the second metatarsal, but there is no loss of the medial arch height. The Lisfranc ligament may be torn, but there is no loss of the medial arch height. The Lisfranc ligament may be torn, but there still are enough ligaments to keep the Lisfranc complex in the correct place.

Stage III results in diastasis greater than 5 mm and reduction of the medial arch height. Both the Lisfranc and the Y plantar ligament are injured.

## IMAGING

As a general rule, it is important to obtain anteroposterior and lateral standing weight-bearing views of both feet to identify any articular incongruence or tarsal bone fractures.

The candle-flame sign, described by Turco, is a diastasis (>5mm) between the medial and intermediate cuneiforms, between the medial cuneiform and the second metatarsal base, or between the bases of the first and second metatarsals, which represents an important ligament lesion. However, only 55% of patients with an important tarsometatarsal lesion showed radiographic signs on plain standing radiographs. For a complete radiographic analysis of a patient, oblique radiographs are recommended to check the congruency of the tarsometatarsal joints.

Stress radiography has been recommended for both acute and non-acute injuries but their reliability is questionable. Magnetic resonance imaging (MRI) is the best method to identify torn ligaments, joint displacements, and possible avulsion fractures but had been proven not to be extremely specific for these lesions.

## TREATMENT

### Non-Surgical Treatment

Nonoperative treatment can be used on Nunley and Vertully Stage 1 Lisfranc injuries. An important concept to help the patient understand is the amount of time this injury takes to heal. The patient needs to realize that a foot sprain does not heal like an ankle sprain. It will require a longer time.

## Surgical Treatment

Surgical treatment is preferred in any Lisfranc injury more severe than Nunley and Vertully Stage 1 injury. Soft tissue and osseous structures can prevent TMT joint reduction. Open reduction with internal fixation (ORIF) and arthrodesis are the two most common operative treatments. Regardless of the operative procedure chosen, it is imperitive to allow soft tissue swelling to resolve before proceeding with operative intervention.

After operative treatment, the patient should be placed in a non-weight-bearing cast for a minimum of 8 weeks. Between 8 and 12 weeks, partial weight bearing is permitted. After 12 weeks, the patient can begin progressive weight bearing with custom orthotics.

The correct indications for primary fusions of Lisfranc fractures and dislocations are major ligamentous disruptions with multidirectional instability/dislocation of the Lisfranc joints and comminuted intra-articular fractures at the base of the first or second metatarsal. An ORIF has to be planned in case of pediatric patients or unidirectional Lisfranc instability.

## CONCLUSION

Lisfranc injuries are a spectrum of injuries of the tarsometatarsal joints that disrupt the midfoot from the forefoot. They range from ligamentous sprains often seen in athletes (low-energy trauma) to fracture dislocations, usually a result of a high- energy injury (misdiagnosed in 20% of the cases).

Conservative treatment is the gold standard for undisplaced lesions. Displaced injuries always require anatomical reduction and internal fixation for an improved outcome. Although evidence to date supports the use of screw fixation, plate fixation may avoid further articular joint damage and may have benefits.

Theoretically, a plantar plating would provide a higher stability, but it is technically demanding and most of the time impossible to perform. There is evidence that in more complex and severe injuries, limited arthrodesis to the medial and middle columns may provide a better outcome.

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***Last reviewed June 2015***